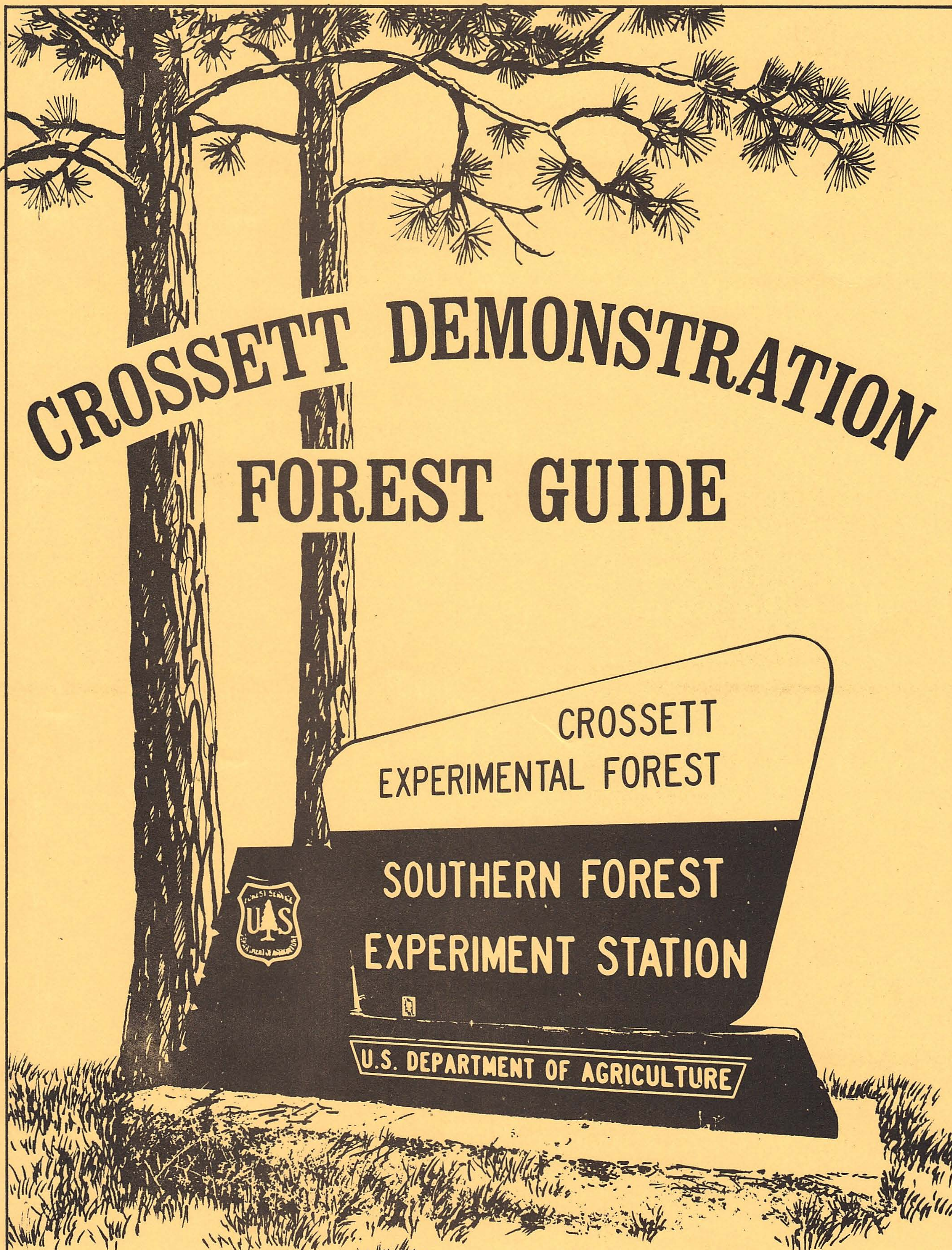
CROSSETT DEMONSTRATION FOREST GUIDE



FORESTRY FIELD DAY

CROSSETT EXPERIMENTAL FOREST

MAY 1, 1985

DENSITY CONTROL IN PINE STANDS

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FORESTRY FIELD DAY
Crossett Experimental Forest
May 1, 1985

FIELD DAY SCHEDULE

9:15-9:30 Welcome and Introductions

9:30-9:45 Overview--The Importance of Density Control (Willett)

Group I (Landowners)		Group II (Foresters)	
10:00-10:45	Density Control in Uneven-aged Stands (Farrar)	10:00-10:40	Density Control in Plantations (Feduccia)
11:00-11:40	Density Control in Plantations (Feduccia)	10:45-11:00	Precommercial Thinning (Cain)
11:45-12:00	Precommercial Thinning (Cain)	11:15-12:00	Density Control in Uneven-aged Stands (Farrar)

12:15-1:30 Lunch and Door Prizes

1:45-2:15 (Groups I & II) Radical Density Control in Plantations (Murphy)

2:15-2:45 Wrap-up and Critique (Baker)

DENSITY CONTROL -- PRINCIPLES AND PURPOSES

R. Larry Willett
Ark. Cooperative Extension Service

One of the most basic forest management practices is controlling stand density (number of trees per acre). We select the initial stocking when we plant seedlings, but regardless of whether we plant or regenerate from seeds the stand will eventually need to be thinned. Density control is based on two concepts. The first principle is that there is a limit to how much wood a given acre of ground can produce depending on rainfall and other conditions in that particular year. Unless it is extremely understocked or overstocked, that acre will produce the same quantity of wood regardless of how many trees are growing on it. We see the effects of this in the trees' diameter growth, since height growth is not affected by how dense the trees are growing. If the growth is spread out over a large number of trees each one will increase in diameter just a little. If there are fewer trees, each one will grow more in diameter.

The second principle is that thinning imitates nature. It just speeds up the sequence of events which would occur naturally during the life of a stand of trees. Typically, a forest begins as many hundreds, even thousands, of seedlings per acre. As soon as the young trees begin to get crowded and compete with each other, the less vigorous trees begin to die out. As the trees grow larger, their number is constantly reduced through natural selection. However, the individual trees that are best suited to survive from the standpoint of natural selection are not always the best ones from the landowner's viewpoint.

Basically, then, we thin for the following reasons:

(1) To increase total yield over the life of the stand. We do this by anticipating natural mortality and removing those trees before they die, rot, and are wasted.

(2) To shorten the rotation. We can grow trees to sawlog size in fewer years by concentrating all the growth on a limited number of crop trees. Although the same number of tons or cubic feet of wood will be produced in either case, larger trees are worth more per unit of volume. Sawlogs, not small trees for chips, are the most profitable product for the private landowner to grow.

(3) To improve product quality. We remove undesirable, unhealthy, and poorly formed trees.

(4) To maintain high tree vigor. Fast-growing trees in thinned stands are healthier and have more resistance to insects and diseases.

(5) To recover establishment costs as soon as possible. The longer your money is tied up, the more you have to make to justify the investment.

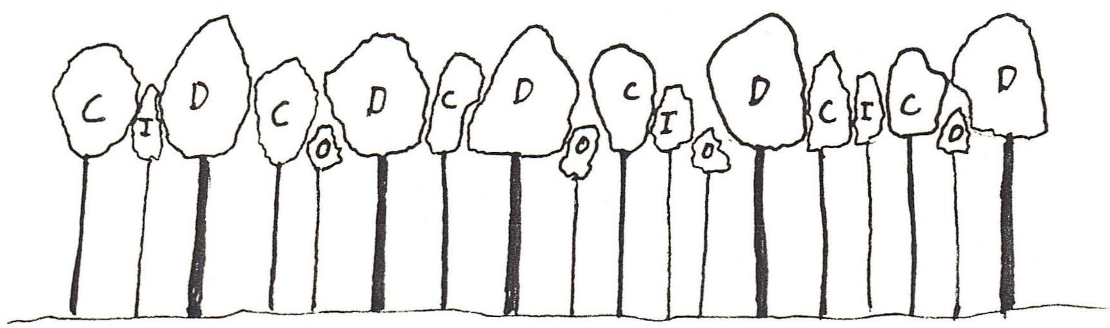
(6) To provide periodic income for the landowner.

(7) To improve access and reduce fire hazard. Small trees get in the way, and they are a potential pathway for wildfire to get into the crowns of your crop trees.

(8) To prepare for regeneration. Thinning around your seed trees about five years before you plan to regenerate helps to insure a good seed crop.

To better understand the principles of thinning, let's first look at the natural development of a stand of trees. As the seedlings grow, they compete with each other for water, nutrients, and growing space below ground and for light and growing space above ground. Gradually the fastest growing trees begin to get ahead of their slower neighbors. The trees that grow most rapidly in height also tend to grow most rapidly in crown size. As the slow-growing trees are crowded by the faster-growing ones, their crowns become more and more misshapen and restricted. Unless some random accident takes out a larger competitor, the weaker trees are shaded out and die. Very few trees ever catch up once they fall behind, and after a point they won't recover even if they are released by cutting larger trees. For this reason, we usually thin to encourage the growth of the most vigorous trees rather than to save those that fall behind.

The competition between trees for room in the crown canopy is easy to see. We call the process "differentiation in crown classes". Here's an example of an unthinned stand of trees of the same species and age:



D = dominant trees - taller than average and get full light from above and partly from the sides. Well-developed crowns but possibly a bit crowded on the sides.

C = codominant trees - crowns form the general level of the canopy and receive full light from above butlittle from the sides. Medium-sized crowns, somewhat crowded on the sides.

I = intermediate trees - shorter, but crowns extend into the crown cover formed by dominant and codominant trees. Receive a little direct light from above but none from the sides. Small crowns, very crowded on the sides.

O = overtopped or suppressed trees - crowns are entirely below the general crown canopy. Receive no direct light either from above or from the sides.

In selecting the trees to be left and those to be removed in thinnings, we look at:

(1) the relative position and conditions of the tree crowns.

(2) the health of the tree

(3) the condition and quality of the trunk of the tree

(4) the species, when more than one are present.

A term you might hear mentioned today is basal area. Basal area is a simple concept that foresters often use when they are talking about stand density or how completely the trees are using the space that's available. If all the big and little trees growing on an acre were cut off leaving a chest-high stump and you then measured and totaled up the area of the circle formed by the top of each stump, you would have found the basal area per acre. It is abbreviated BA/A and is expressed in square feet. Actually, of course, we have an instrument to measure basal area without actually cutting the trees or even measuring them individually.

What does basal area tell you? Well, suppose that someone says that the average density of a stand of timber is 85 square feet per acre. You know that is less densely stocked than another tract that has an average BA/A of a 110 sq. ft. Or suppose two stands of trees both have 80 sq. ft. of basal area per acre. If one stand is of young trees averaging 4 inches in diameter and the other is older and averages 20 inches, you know right away that there must be a large number of 4 inch trees per acre in the young stand and a smaller number of 20 inch trees in the older one. However, the stands are equally well stocked, because the many small trees add up to the same BA/A as do the larger trees in the older stand. The many small trees will use the space, light, water, and nutrients on the acre of ground to the same extent as the smaller number of larger, older trees.

DENSITY CONTROL IN UNEVEN-AGED NATURAL STANDS

Bob Farrar

I. Definitions

Regulated Forest - One where age and/or size classes are represented and growing such that nearly equal periodic yields are obtained.

Uneven-aged Stand - One that contains 3 or more distinct age classes. In practice it exhibits a reverse-J dbh distribution.

Balanced Uneven-aged Stand - One whose dbh distribution is a smooth reverse-J (negative exponential) with a constant ratio between adjacent dbh classes.

q - The constant ratio of the number of trees between adjacent dbh classes is called "q".

Irregular Uneven-aged Stand - One whose dbh distribution is a "ragged" reverse-J. The q is not constant.

Selection System - A silvicultural program aimed at the creation and maintenance of uneven-aged stands.

Selection Method - Activities employed for the regeneration of uneven-aged stands. There are several modifications:

Single-tree = removal of scattered individual trees or very small clumps for regeneration.

Group = removal of scattered patches of trees.

Dauerwald = similar to single-tree but no thought given to regeneration.

Diameter-limit = primitive, removal of all trees in and/or above a specified dbh class.

"Selective cutting" and "economic" selection or "high-grading" are not valid selection methods.

Cutting Cycle - The specific name of the time interval (years) between cuts in a selection stand.

"Free" Thinning - Probably the best definition of the type of cutting properly done in a selection stand - trees are often removed from all merchantable size classes as dictated by a residual structure target and silvicultural need.

Site Quality - Site index is specific to even-aged stands but we use it to assess the site quality of uneven-aged stands by selecting site trees that have apparently (from their ring patterns) been D or CD trees all their lives.

II. Selection Contrasts with Even-aged

Age Classes - Age is actually ignored in uneven-aged stands. Cutting cycle substitutes for age in selection stands. Even-aged stands typically have a mean age with a range $\leq$ 1/5 of the rotation and this age class occupies a defined land area.

Reproducton - Uneven-aged stands are reproduced naturally by a selection method. Even-aged stands are reproduced naturally by clear-cutting, seed-tree, or shelterwood methods and by clear-cutting and planting seedlings, seed, or cuttings.

Tenure - Selection stands have no start or end point in time; regeneration, recruitment, thinning, and harvest are periodically continuous. Even-aged stands are reproduced, grown, thinned, and harvested at rotation age and a new stand is reproduced.

Structure - Uneven-aged stands have an irregular canopy top and a wide dbh distribution with most stems in the smallest dbh class. Even-aged stands have an almost level canopy top and a narrow dbh distribution with most stems in the middle classes.

Understory control - Control of unwanted woody vegetation in selection stands is principally by harvesting and chemical means. Chemical re-treatment may be required about every 10 years. Prescribed cyclical burning can be used for control in even-aged stands along with harvesting and perhaps some need for chemicals before or during the regeneration period.

Density control - Uneven-aged stand density is typically controlled by periodic thinning and harvesting throughout the dbh distribution by manipulating the stand table. Even-aged stand density is typically controlled by periodically thinning in the lower part of the dbh distribution by manipulating the basal area or trees per acre. Uneven-aged stands usually contain fewer merchantable trees and less basal area than even-aged stands.

Regulation - Uneven-aged stands are usually regulated via control of the growing stock volume (actually, control of the stand table). Even-aged stands are usually regulated by area control or the area occupied by each age class (rotation/cut interval = number of age classes). In a selection system, the stand can be and often is the unit of regulation and can be as small as 30 acres. In an even-aged system, the forest, containing a stand of each age class, is the unit of regulation and is usually much larger. Selection stands are often fully regulated more quickly and more easily than a forest of even-aged stands.

Other - Selection stands are usually less susceptible to damaging agents. Selection management is somewhat more complicated (periodic inventories are essential) but regulation is simpler. Even-aged management is simpler but regulation is more complicated. It is easier to convert from selection to even-aged than the reverse.

III. Regulation Methods

A. Volume - Guiding Dbh Limit (V-GDL)

1. Make before-cut inventory, develop a stock table
2. Determine Doyle compound growth rate
3. Determine end of cutting cycle target volumes [75 BA (80% sawt. BA), 2000 MerCF, 7000 Doyle]
4. Calculate Doyle cut allowable to reach target in 5 years
5. Mark the cut (leave best, cut worst; thin sub-sawt.)
6. Cut (minimize damage to residual stand and soils)

Example

1. Before-cut Inventory / 4. Cut

	Dbh	TPA	BA	MerCF	Doyle	Cut Doyle
	4	59.6	5.2	30	0	0
	6	44.1	8.7	150	0	0
	8	29.7	10.4	234	0	0
	10	22.2	12.1	312	624	0
	12	14.9	11.7	328	835	0
	14	10.1	10.8	320	1038	0
	16	6.1	8.5	263	1027	0
gdl>	18	2.7	4.8	152	682	641
	20	1.3	2.8	92	463	463
	22	0.7	1.9	60	334	334
	24	0.3	0.9	31	186	186
		191.7	77.8	1972	5189	1624

2. Doyle compound growth rate = 7% (from increment cores).

3. Want 5 Mbf Doyle at end of 5-year cutting cycle so,

   since $V_n = V_o(1+p)^n$ then $5000 = V_o(1.07)^5$ and $V_o = 5000/1.40$

   thus $V_o = 3565$. Proof: $3565(1.07)^5 = 5000$.

4. Cut = 5189 - 3565 = 1624 Doyle (see gdl above) plus thinnings but leave BA = 60 +/- 5 (and about 75% sawt. BA).

Common selection growth rates: BA = 3 sq. ft./ac./yr.
sawt. BA = 1%/yr.
MerCF = 80 cu. ft./ac./yr.
Doyle = 300 fbm/ac./yr.

So, in 5 years we should have BA = about 75
sawt. BA = about 80%
MerCF = about 2000
Doyle = about 5100.

If we wanted to increase growing stock toward 7000 Doyle, we would cut less initially.

B. Basal Area - Maximum Dbh - q (B-D-q)

1. Make before-cut inventory, develop a stand table
2. Develop target residual structure
   (B = 60, D = 18, 2"q = 1.4)
3. Adjust residual target to cover deficits
4. Determine cut = (b-c inventory) - (adj. residual)
5. Mark cut (leave best, cut worst in each cut dbh class)
6. Cut (minimize damage to residual stand and soils)

Example

1. Before-cut Inventory

Dbh	TPA	BA	MerCF	Doyle
4	59.6	5.2	30	0
6	44.1	8.7	150	0
8	29.7	10.4	234	0
10	22.2	12.1	312	624
12	14.9	11.7	328	835
14	10.1	10.8	320	1038
16	6.1	8.5	263	1027
18	2.7	4.8	152	682
20	1.3	2.8	92	463
22	0.7	1.9	60	334
24	0.3	0.9	31	186
	191.7	77.8	1972	5189

2. Target Residual

Dbh	TPA	BA	MerCF	Doyle
4	44.1	3.9	23	0
6	31.5	6.2	107	0
8	22.5	7.9	177	0
10	16.1	8.9	226	452
12	11.5	9.0	253	643
14	8.2	8.8	260	843
16	5.9	8.2	253	986
18	4.2	7.4	235	1057
	144.0	60.3	1534	3981

3. Adjusted Residual

Dbh	TPA	BA	MerCF	Doyle
4	44.1	3.9	23	0
6	31.5	6.2	107	0
8	22.5	7.9	177	0
10	16.1	8.9	226	452
12	11.5	9.0	253	643
14	10.1	10.8	320	1038
16	6.1	8.5	263	1027
18	2.7	4.8	152	682
	144.6	60.0	1521	3842

4. Cut=(b-c inv.)-(adj. r.)

Dbh	TPA	BA	MerCF	Doyle
4	15.5	1.3	7	0
6	12.6	2.5	43	0
8	7.2	2.5	57	0
10	6.1	3.2	86	172
12	3.4	2.7	75	192
14	0	0	0	0
16	0	0	0	0
18	0	0	0	0
20	1.3	2.8	92	463
22	0.7	1.9	60	334
24	0.3	0.9	31	186
	47.1	17.8	451	1347

The above growth rates apply. Also, D will increase about 0.4"/yr. and the 2"q will decrease about 0.1 in 5 years. Thus, in 5 years we can expect to have a stand with a D of about 20", a 2"q of about 1.3 and: BA = about 75
MerCF = about 1900
Doyle = about 5300.

DENSITY CONTROL IN PINE PLANTATIONS

Don Feduccia

The following is a brief discussion on density control in pine plantations. For more detail see the publication in your handout entitled, "Thinning Pine Plantations."

Major points to consider when thinning plantations:

A. Thinning, with its many aspects, is a controversial subject among the forest managers of the South. You as landowners and/or foresters should keep in mind that management decisions concerning thinning should be based on a clear definition of an individual landowner objectives.

B. Five factors influence the growth and development of a pine plantation:

* 1. Spacing or number of seedlings planted per acre. How many to plant per acre?

(a) >900 pulpwood only - impractical - costly - retards growth
(b) 900-600 - pulpwood plywood, sawlogs, poles
(c) 400-600 - Sawlogs
(d) <400 - risky

thinning plays a secondary role

2. Timing of the first thinning - When to thin?

(a) When live-crown ratios are between 40-50% or
(b) When basal area per acre $\geq$ 110 sq. ft. per acre.

3. Thinning method - How to thin?

(a) Selective - remove or leave a tree based on individual characteristics, including their relationship to neighboring trees.

(b) Mechanical - Trees to be cut or retained are chosen on the basis of a predetermined spacing without regard to their position in the crown canopy.

Two types:
1. Row
2. Corridor

(c) Combination of selective and mechanical - first thinning only.

4. Thinning intensity - How much to leave or cut?

   (a) Leave - Heavy thinning <70 sq. ft./acre
   Medium thinning 70-90 sq. ft./acre
   Light thinning >90 sq. ft./acre

   (b) Cut - minimum of 3-6 cords or 1,000 to 1,500 bd ft. per acre.

5. Interval between cuts - How often to thin?

   Every 3-10 years.

C. With a rotation of 35 years or less, commercial thinnings will play only a minor role in the development of a plantation. With short rotation, leaving the plantation unthinned will produce maximum cordwood yield. Landowners wishing to harvest intergrated product should make early and repeated thinnings. Some cordwood yield will be sacrified due to thinnings, but the operation will result in larger, higher value stems at the end of the rotation .

D. To harvest sawtimber or veneer logs as soon as possible, carefully consider the initial planting spacing and make early, repeated thinnings. Heavy thinnings increase diameter of residual trees but do not fully occupy the growing spacing and tree mortality can create openings that aggrevate the low-density situation. Moderate or light thinnings leave more trees to choose from in subsequent thinnings, and a reasonable insurance against risk from destructive agents

SIMULATED LOBLOLLY PINE PLANTATION
Site index 90 feet at age 50 (good site)
Planted 700 seedlings per acre

	Thinned					Unthinned				
	TPA	BA	Avg.dia.	Cds.	Bd.ft.	TPA	BA	Avg.dia.	Cds.	Bd.ft.
Age 15										
BC	491	116	6.6	16	-----					
C	158	31	6.0	5	-----					
AC	333	85	6.8	11	-----					
Age 21										
BC	292	111	8.4	25	-----					
C	109	31	7.2	9	-----					
AC	183	80	8.9	16	-----					
Age 28										
BC	168	100	10.5	12	4,500					
C	54	25	9.2	5	1,200					
AC	114	75	11.0	7	3,300					
Age 35										
BC	109	91	12.4	7	7,100	249	161	10.9	18	9,800
C	31	21	11.2	3	1,600					
AC	78	70	12.8	4	5,500					
Age 45										
	73	84	14.7	4	9,845					

PRECOMMERCIAL THINNING AND MANAGEMENT OF NATURAL EVEN-AGED PINE STANDS

A Demonstration of a Proven Technique

Michael D. Cain

INTRODUCTION

Considerable research has been done emphasizing the need for precommercial thinning in dense, young stands of loblolly-shortleaf pine (Bower 1965, Keister and McDermid 1968, Grano 1969, Lohrey 1972 and 1977, Jones 1974, Williams 1974). When properly executed, such thinnings can increase the growth and shorten the rotation of crop trees. For example, it was found that, 12 years after precommercial thinning an 8-year-old natural loblolly pine stand near Crossett, Arkansas:

(1) average dbh was 25 percent larger than unthinned plots,
(2) total yield was 4.5 cords per acre more than unthinnied plots and
(3) total yield was 112 percent greater than unthinned plots.

For best volume gains, density of natural loblolly pine stands should be reduced to between 500 and 750 stems per acre.

PRESENT DEMONSTRATION

History:

A ten-acre strip (Figure 1) was clearcut and site prepared in 1971 for the establishment of a progeny test. In 1972, pine seeded in from adjacent pine stands, but that regeneration was mowed in 1973 to maintain a site-prepared area for planting. In 1974-75, the area reseeded naturally with loblolly and shortleaf pine and remained undisturbed until 1979. At that time the area contained an average of 16,600 pine seedlings per acre.

Treatments:

In October 1979, twelve 0.4-acre plots were established and six were precommercially thinned. The remaining six plots were left unthinned.

Mechanical strip-thinning, a proven precommercial thinning technique, was used throughout. Cut swaths are 12 feet wide and alternate with 1-foot-wide uncut strips. Thinning was done with a 6-foot-wide, heavy-duty rotary mower (Bush Hog, Model 406) attached to an industrial-size, wheeled tractor (Ford 532, diesel). A time study showed that this 10-acre area could have been thinned at 1.5 acres per hour.

In the winter of 1982-83, a prescribed burn was conducted across all twelve plots for fuel hazard reduction. Prior to that burn, three additional plots of 0.4 acre were established to provide growth data in undisturbed controls. In February of 1985, a second biennial prescribed burn was conducted on the original twelve plots.

Results:

Precommercial thinning resulted in an 89 percent reduction in pine density. Of the residual 1,920 stems per acre in October 1979, 650 were ≤ 4.5 feet tall, 860 were between 5.0 and 9.5 feet tall, and 410 were ≥ 10 feet tall. Stems 10 feet and taller at the time of thinning will probably become the crop trees.

As a result of natural mortality and prescribed burning, pine density changed dramatically on unthinned plots. In the winter of 1983-84, four years after precommercial thinning, density was 2,500 pines per acre, 5,900 pines per acre and 6,900 pines per acre on thin/burn, unthin/burn, and undisturbed control plots respectively. Because of more stems per acre, total cubic-foot volume per acre on unthinned plots was about 5 times higher than that on mechanically thinned plots. However, the long-range goal is rapid sawlog production; for that, diameter growth must be accelerated. Four years after precommercial thinning, dominant pines (trees 20 feet and taller) on thinned plots had mean diameters above merchantable size (4-inch dbh class). On unthin/burn plots and on undisturbed controls, dominant pines had not yet reached merchantability.

CONCLUSIONS

Does precommercial thinning pay for itself? That depends on when it is done. The cost, of course, depends on tree size and number of stems per acre, hence it is important to thin as early as possible. Costs can be very high in extra dense stands, but the financial rewards can also be high as born out by numerous research studies. Precommercial thinning (combined with hardwood control at time of regeneration) has been found, in some cases to increase financial returns by as much as four to six times that of no treatment. So the answer is that precommercial thinning can, indeed, more than pay for itself if the stand is thinned at an early age and costs are reasonable.

A properly done precommercial thinning leaves a stand looking decimated. Remember, the key to success is to thin early! Unfortunatly, most precommercial thinning is done "too little, too late."

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GLOSSARY

Cord -- A stack of round or split wood containing 128 cubic feet of wood, bark, and air space. A standard cord measures 4 feet by 4 feet by 8 feet.

DBH -- Diameter Breast height; tree diameter measured 4.5 feet above ground level.

Precommercial thinning -- A cutting in an immature stand to reduce the number of trees per acre, primarily to accelerate diameter growth.

Prescribed fire -- Controlled use of fire to achieve forest management objectives. Fire used to reduce hazardous fuels, control unwanted vegetation, improve visibility, and improve wildlife habitat.

Progeny test -- A test in which the genetic constitution of an individual tree is evaluated from the performance of its descendants.

Rotation -- The number of years needed to establish and grow trees to a specified size, product, or condition of maturity.

Sawlog -- Trunk portion of a tree large enough to be sawn into lumber; the tree is usually at least 10 inches in diameter.

Stand -- A community of trees that are sufficiently uniform in composition, age, and spatial arrangement so as to be distinguishable from adjacent communities.

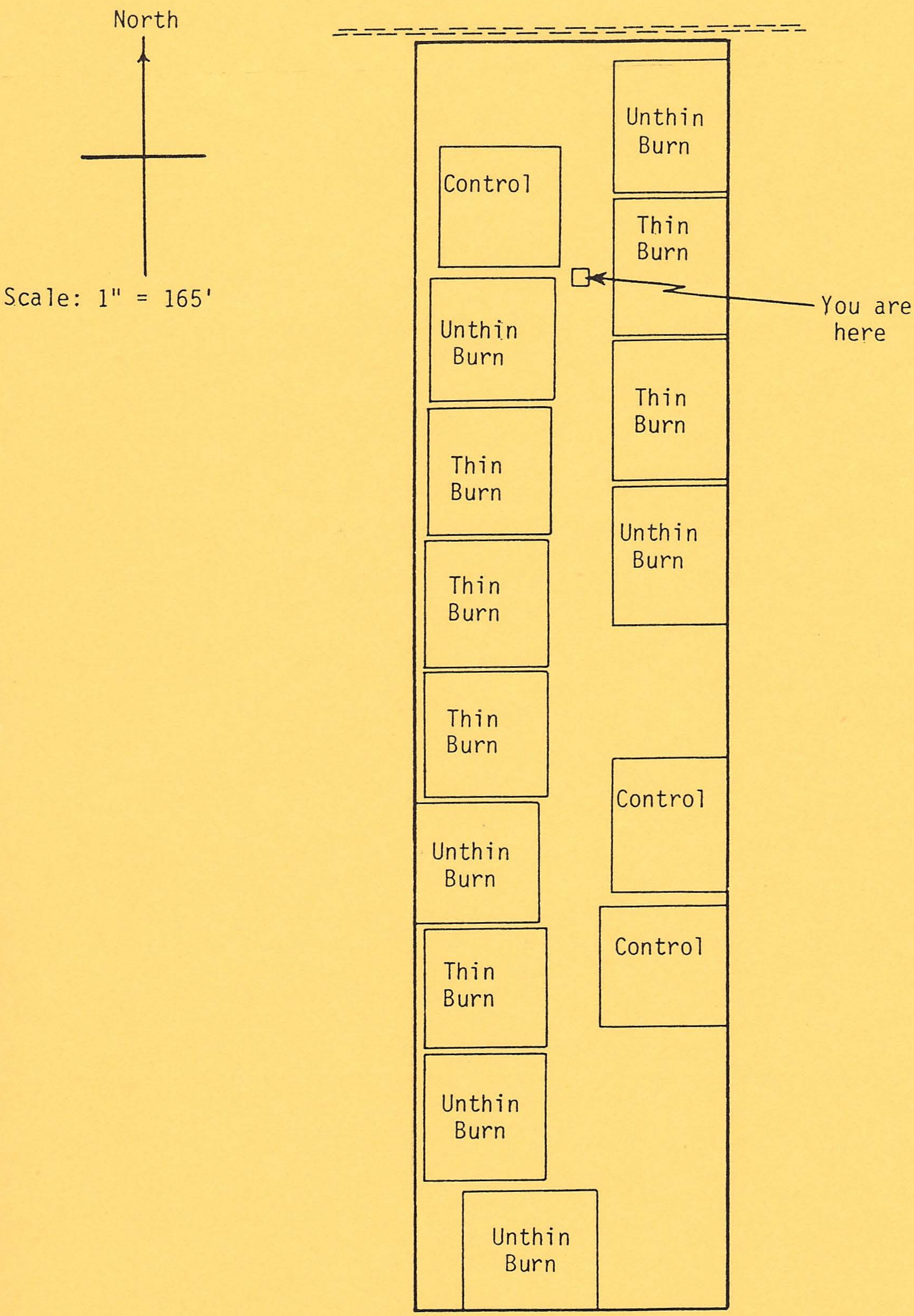

Figure 1. --Field location of 0.4-acre plots in precommercial thinning demonstration.

EARLY AND RADICAL DENSITY CONTROL IN PLANTATIONS

Paul A. Murphy

The purpose of this stop is to demonstrate that good quality sawtimber can be produced on a short rotation by intensive cultural practices.

Stand History

The Crossett Lumber Company (now Georgia-Pacific Corporation) planted loblolly pine on a 6x6 foot spacing (about 1210 trees per acre) on an old field in the winter of 1944-45. At age 9, a study was installed consisting of four thinning treatments that was duplicated three times. These treatments range from a "standard practice" or "conventional" treatment to the most radical that was called "sawtimber only". The purpose of the radical thinning was to attempt to produce 16-inch sawlog size trees in 30 years. A comparison of the extreme treatments reveals the gains that can be realized from aggressive thinning.

Description of Treatments

Conventional--Plots were thinned, mainly from below, to 85 square feet of basal area per acre at age 12 and every 3 years afterward. Stand densities were reduced to 712 stems per acre at age 12 years, 468 at 15 years, 333 at 18 years, 251 at 21 years, 193 at 24 years, 148 at 27 years, and 116 at 30 years.

Sawtimber Only--Plots were precommercially thinned to 100 crop trees per acre at age 9. Subsequent thinnings reduced the density to 76 trees per acre at age 19, 64 trees at age 24, 48 trees at age 27, and 41 trees at age 30. Crop trees were pruned to one-half their total height after the first thinning and every three years afterwards until clear length averaged 33 feet at age 24. Understory vegetation was controlled by mowing every two years, beginning at age 19.

The purpose of the heavy thinning and understory control was to reduce competition for soil moisture and thereby accelerate growth of the crop trees. Artificial pruning was done to ensure obtaining two high quality sawlogs from each crop tree.

Results

The basal areas for the two treatments at different ages for before- and after-thinning are summarized in table 1. Notice that radical thinning reduced basal area at age 9 to only 10 square feet per acre and that the first commercial thinning occurred at age 19. In contrast, the conventional treatment thinnings occurred every 3 years. The timing of the commercial thinnings in the sawtimber-only treatment was to keep the trees growing faster than the crop trees in the other treatments.

Production and inventory statistics are found in table 2. The conventional treatment had about three times the number of trees at age 33 as the sawtimber-only, but the average diameter was only 12.3 inches versus 18 inches for the sawtimber-only. The sawtimber-only treatment also had more sawtimber volume.

The production figures are also revealing. Production here is the sum of the volumes removed in thinning plus the inventory at age 33. The conventional treatment produced almost 2,000 cubic feet of pulpwood versus a minuscule 314 cubic feet for the sawtimber-only. However, the sawtimber-only produced twice the board-foot volume as the conventional treatment, 12.2 thousand versus 6.4 board feet.

Conclusion

What thinning technique should the landowner employ--a conventional type that produces a lot of pulpwood or a very radical one like the sawtimber-only treatment used in this study? The answer for most landwoners probably lies within these two extremes.

In retrospect, the intensive methods used in this study could be changed to reflect current conditions. An initial spacing of 6x6 feet is too close, especially if the objective is to produce sawtimber quickly. Other studies have shown that 10x10 or 10x12 spacings are more effective and reduce planting costs. Slightly closer spacings, say 8x8 or 8x10 may be used, if disease or insect problems deform trees. These closer spacings provide more trees from which to select potential crop trees, and provide natural pruning.

Heavy thinning is important. The first pulpwood thinning should occur at about age 12. A commercial thinning is possible at this age, and if thinning occurs much later, diameter growth will begin to slow down.

Pruning is necessary if early and radical thinning is used. But the light and frequent pruning used in this study is not economical. It should only be done once when the crop trees are tall enough to leave a 50 percent live crown after pruning is done 17.3 feet up the bole. Pruning should be confined only to the best trees that are destined to form the final crop. However, in today's economic climate pruning is probably not feasible unless the landowner is assured of receiving a premium price for pruned trees.

Competing understory vegetation robs trees of water needed to sustain maximum growth, especially during dry periods, so some form of understory vegetation control is necessary. Prescribed every 2-3 years would be easier and cheaper than mowing. Burning also reduces hazard from wildfire and makes the stand more accessible for management.

Under proper conditions, sudden sawlog culture should produce sawlogs of a sufficient quality in 30 years and also provide a good financial return to the landowner. All intensive treatments should be employed--wide spacing, heavy thinning, and understory competition control-- to insure maximum production. This intensive managemnt is recommneded only for high quality sites (site index 90 feet or better at 50 years) where the erosion hazard is slight.

Source: Burton, J.D. 1982. Sawtimber by prescription--the sudden sawlog story through age 33. USDA For. Serv. Res. Pap. SO-179, 9p. South. For. Exp. Stn., New Orleans, LA.

Table 1.--Basal area per acre before and after thinning.

Age	Sawtimber-only		Conventional	
	Before cut	After cut	Before cut	After cut
-Years-	----------------------ft² per acre			-----------------
9	71	10	74	74
12	25	25	124	85
15	47	47	119	84
18	69	69	113	85
19	75	60	90	90
21	69	69	103	85
24	82	70	103	85
27	84	65	104	85
30	76	65	101	82
33	70	70	97	97

Table 2.--Inventory and production per acre by treatment through plantation age 33 years.

Variable	Treatment	
	Sawtimber-only	Conventional
	---Inventory---	
Number of trees	41	116
Average diameter (ins.)	18.0	12.3
Basal area (ft^2)	70	97
Doyle volume (fbm)	8,870 1/	5,990 1/
	---Production---	
Pulpwood (ft^3)	314 2/	1,992 2/
Doyle volume (fbm)	12,220 1/	6,410 1/

1/ Volume in trees at least 9.6 inches dbh containing at least one 16-foot log to a 6-inch top, inside bark.

2/ Volume in trees from 4.6 to 9.5 inches dbh containing at least two 63-inch bolts to a 3-inch top, inside bark.